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Reconstructing representative daily milk FT-MIR spectra from partial milking robot samples using machine learning

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ICAR conference 2026

Avec le soutien de la Wallonie

Interreg North-West Europe
Co-funded by the European Union
HoliCow

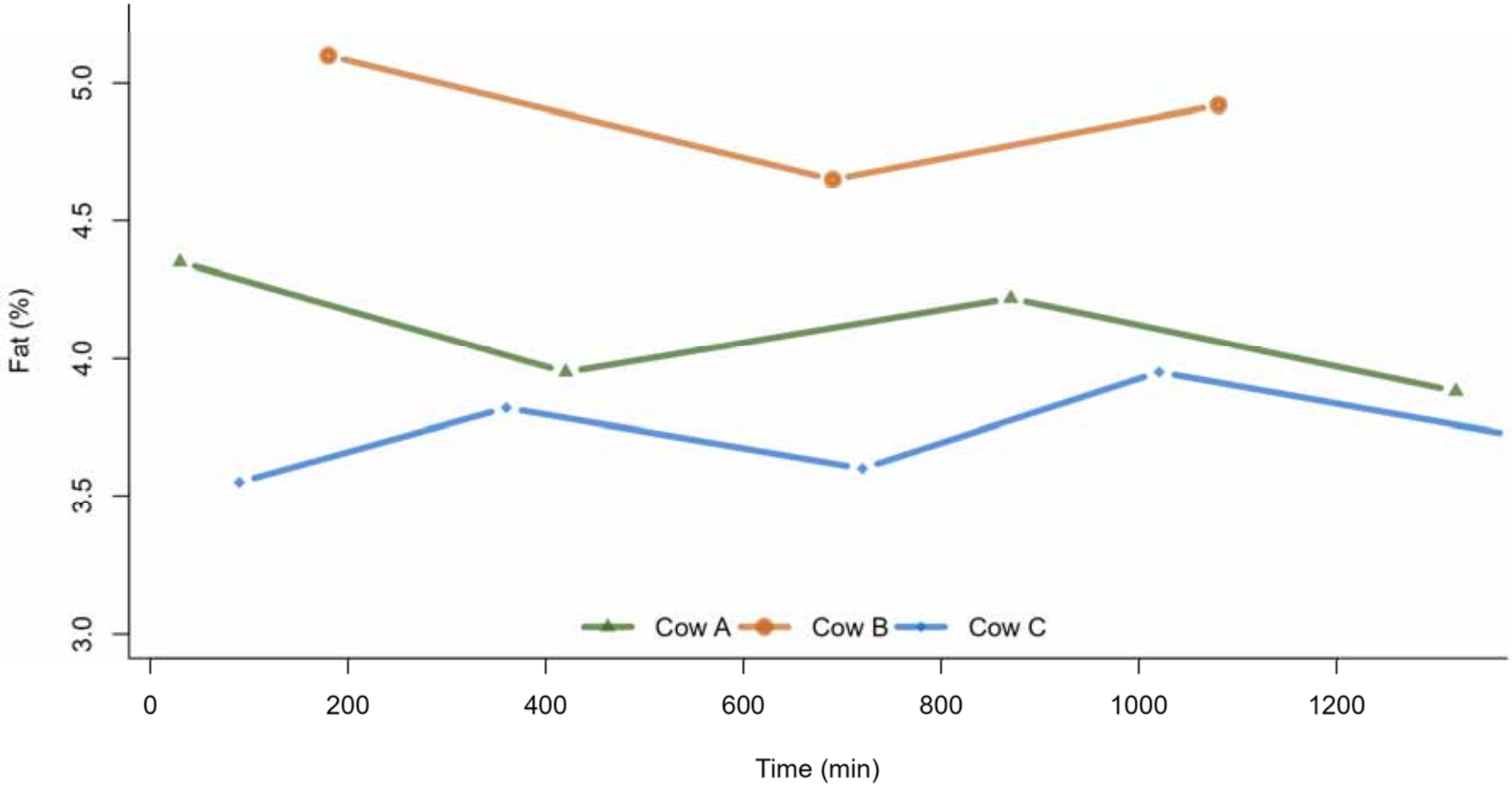
Automated Milking System (AMS)

- Increasingly common in modern dairy farming.
- One out of four dairy farms in Danemark and Sweden
- Continuous collection of data.

(Cogato et al., 2021; Hassoun et al., 2023; Zagidullin et al., 2023)

https://corporate.delaval.com/

Evolution of milk fat over a day



Illustrative example

Correction for Fat and Protein

THE GLOBAL STANDARD
FOR LIVESTOCK DATA

Procedure 1 of Section 2 of ICAR Guidelines - Computing 24-hour Yields

Methods to calculate 24-hour yields in Automatic Milking Systems

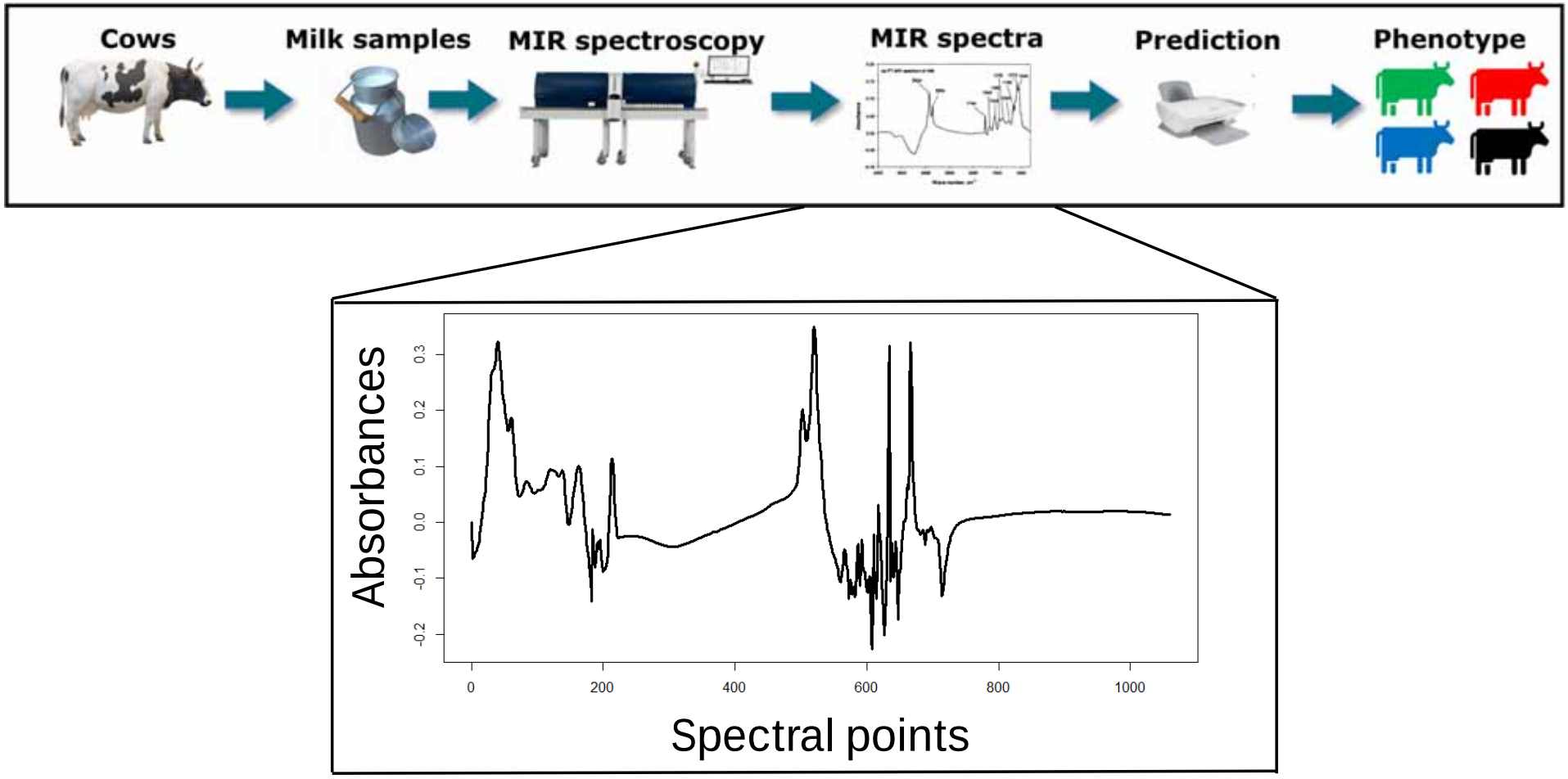
Computing 24-hour Yields

Version June, 2023

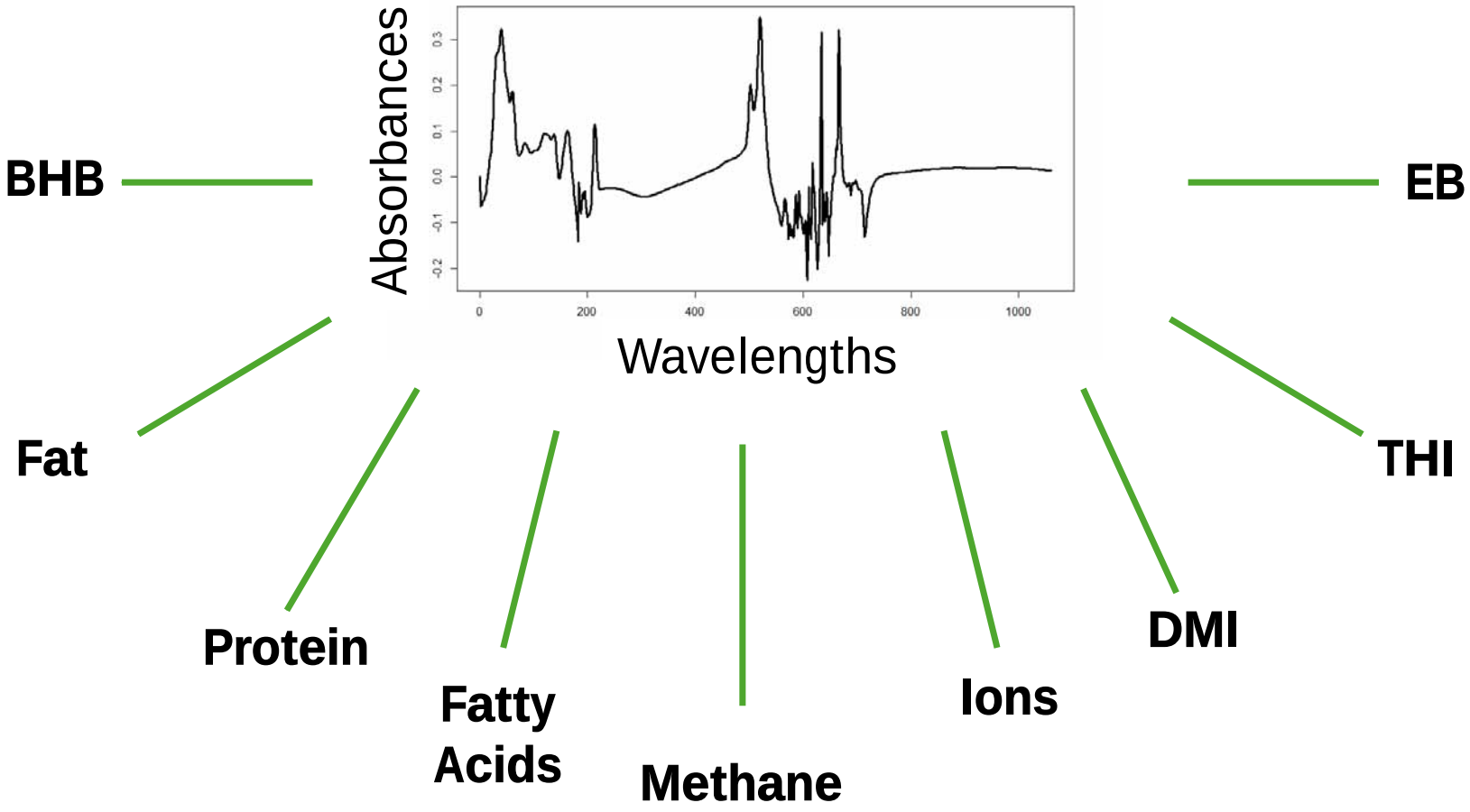
=> Peeters and Galesloot (2000)

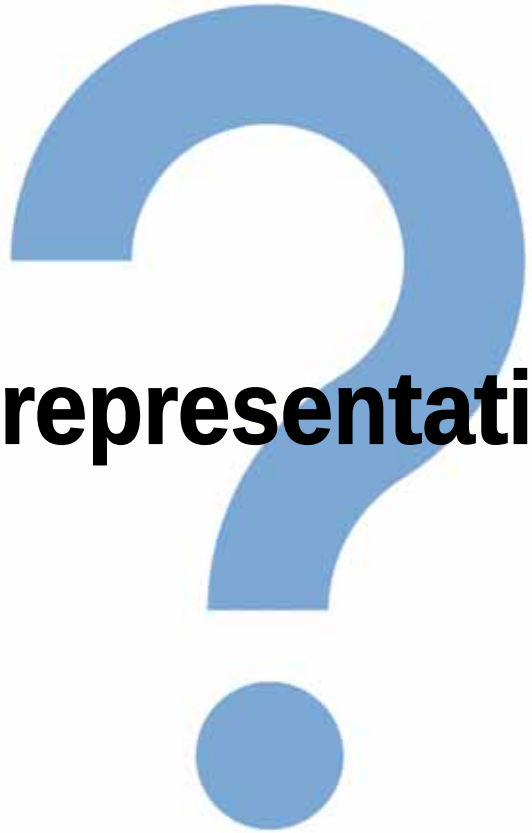
What about other traits than Fat and Protein?

What is Fourier Transform mid-infrared spectrometry ?



Predictions? Phenotypes ?





Can we create a representative daily spectrum?

Datasets

Data used to train the methods or find coefficients

Data Train: Fat and Prot	Data Train: Spectra	Data Validation
• 3 farms	• 2 farms	• 7 farms
• 227 Milk Recording Events	• 130 Milk Recording Events	• 7 Milk Recording Events
• Between 2014 and 2025	• Between 2013 and 2025	• Between Feb and April 2025
• 1,428 cows	• 450 cows	• 873 cows
• 39,395 records	• 10,239 records	• 2,465 records

All samples were analyzed.

Methods for estimation of Fat and Prot 24h

1. PG = ICAR Certified: Peeters and Galesloot (2000)
2. WA = Weighted average
3. LM = Linear regression

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With only one milking:

$$\%FAT\_24h = a + b \times \%FAT + c \times \%PROT + d \times MI + e \times MY + f \times pMY$$

↳ 6 coefficients (a, b, c, d, e et f)

	Milking Interval (minutes)				
$\frac{\%FAT}{\%PROT}$	Class	]0;361[	[361;511[	[511;701[	[701;1441[
	<1.1	1	2	3	4
	[1.1;1.25[	5	6	7	8
	[1.25;1.4[	9	10	11	12
	>1.4	13	14	15	16

16 classes of 6 coefficients (a, b, c, d, e and f)

Methods for estimation of Fat and Prot 24h

2. **WA = Weighted average**

With more than one milking:

$$\%\boldsymbol{FAT24h} = \frac{\sum(\%\boldsymbol{FAT} \times \boldsymbol{MY})}{\sum \boldsymbol{MY}}$$

Methods for estimation of Fat and Prot 24h

3. LM = Linear regression

With one or more milking:

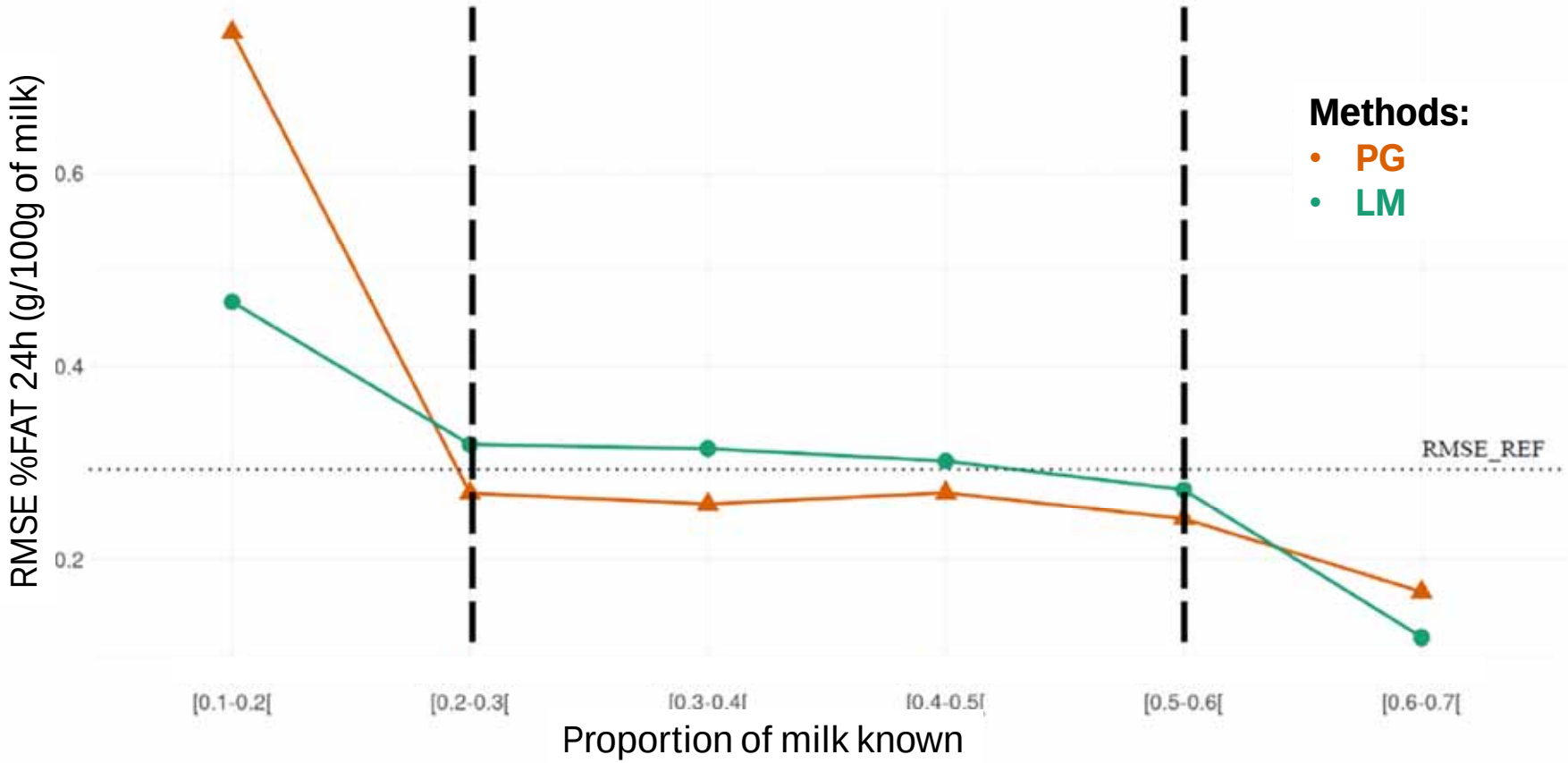
$$\%FAT24h = \frac{FAT_{known} + FAT_{pred}}{\sum MY}$$

Where $FAT_{pred} = MY + MY^2 + \%PROT + MI + pMI$

With MY = Milk Yield, MI = Milking Interval and pMI = previous Milking interval

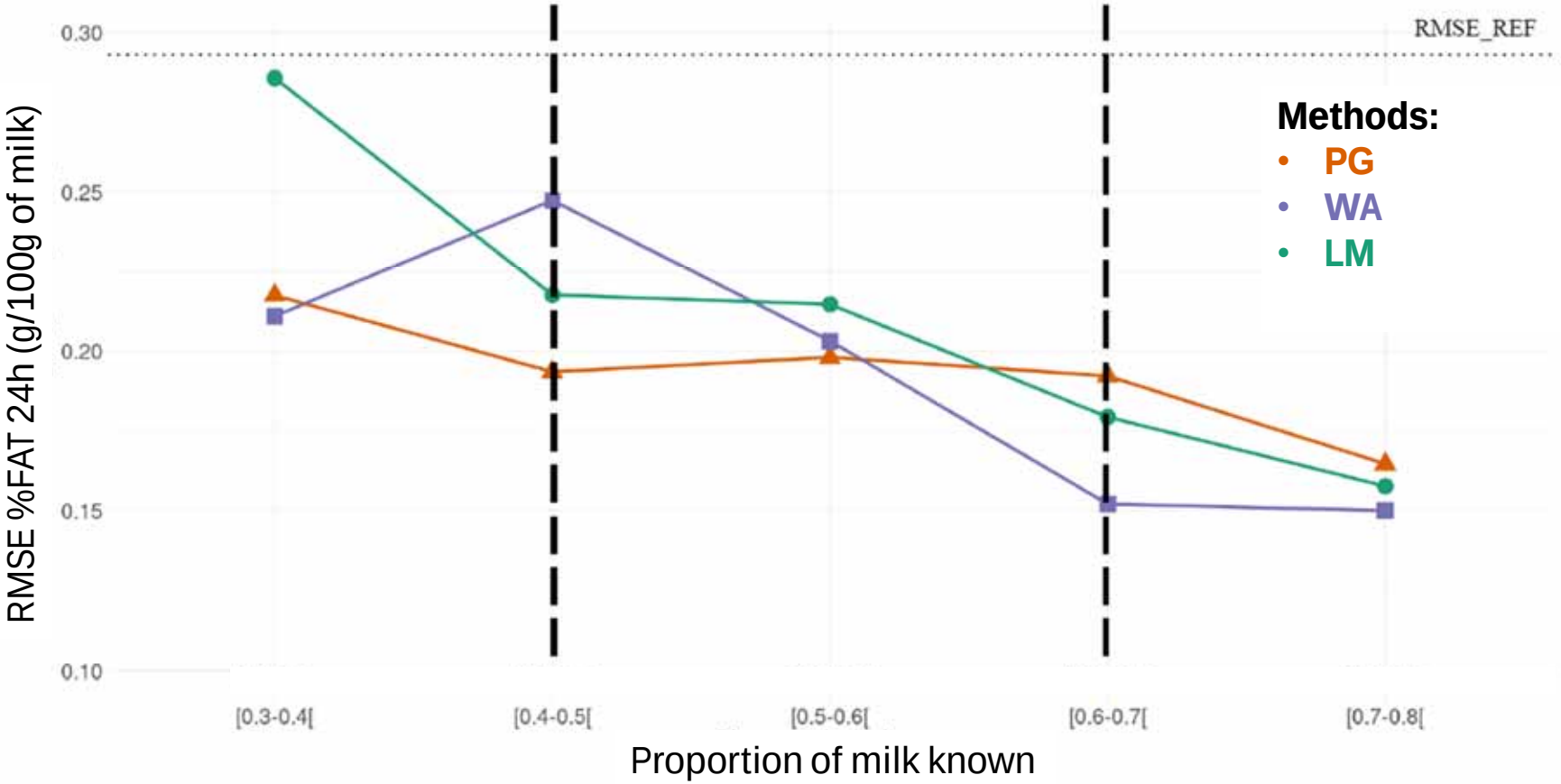
Errors on FAT24h by proportion of milk known

Using only one milk sample:



Errors on FAT24h by proportion of milk known

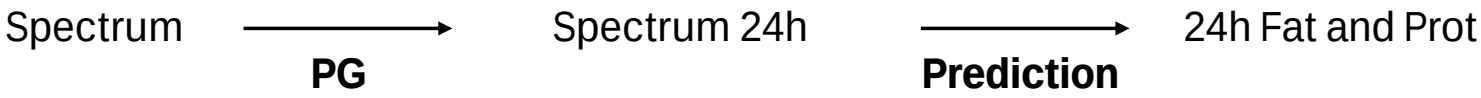
Using only two milk samples:



Methods for estimation of Spectra 24h

Each wavelengths is processed independently:

PG1: Peeters and Galesloot with one milk sample



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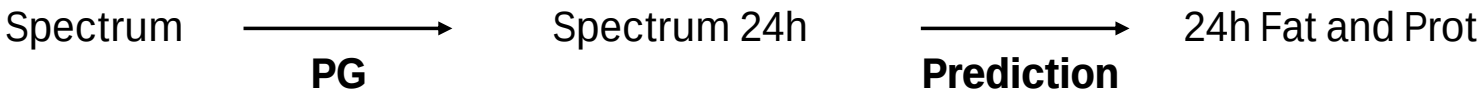
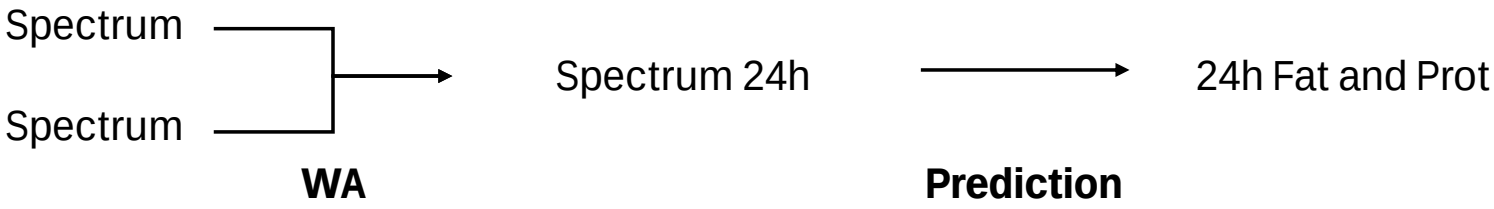
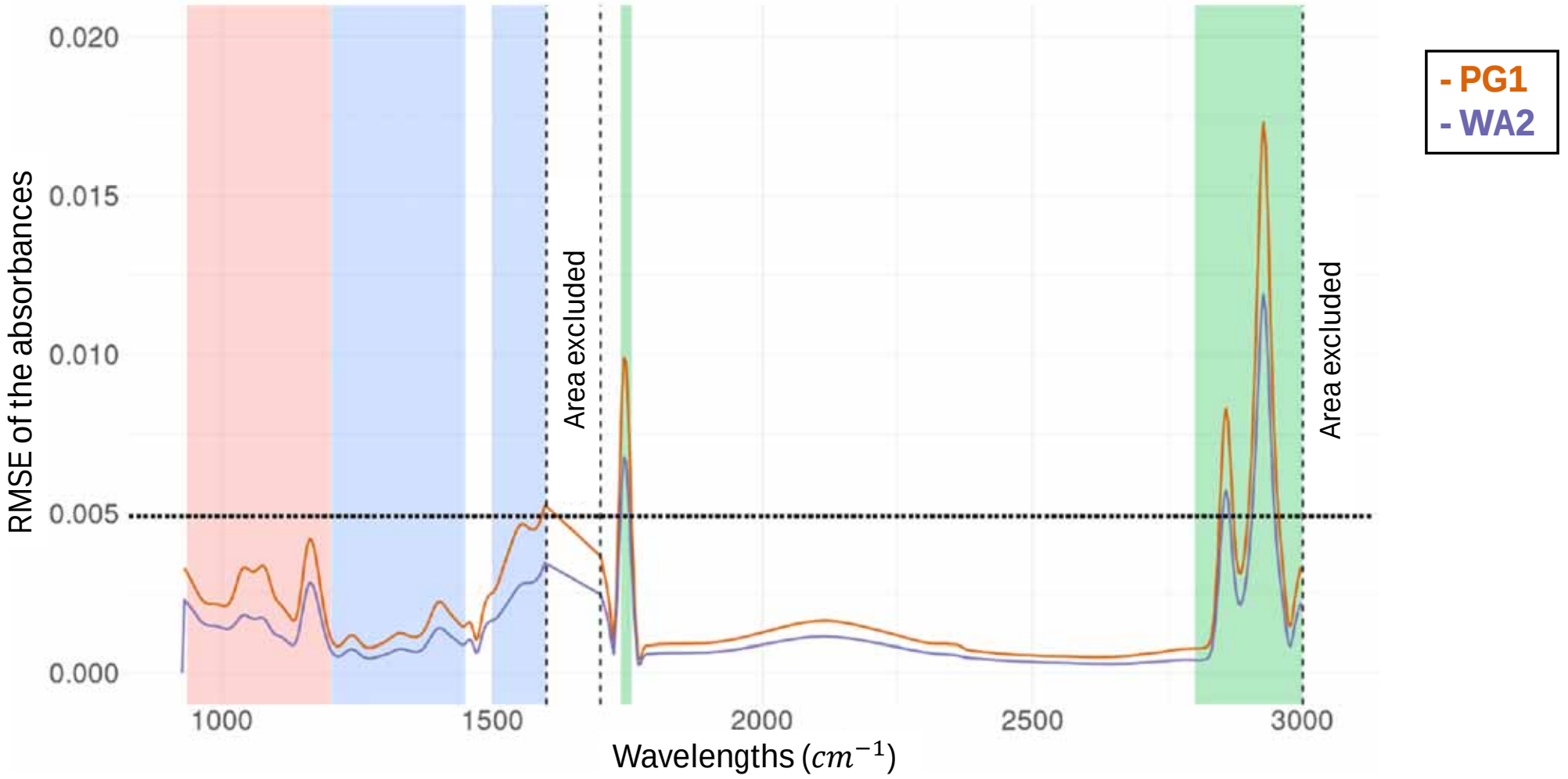


WA2: Weighted Average with two milk samples



RMSE of Spectra 24h

- Lipids Area
- Proteins Area
- Carbohydrates Area



RMSE of Fat and Protein 24h from spectra 24h

	RMSE Fat24h (g/100g of milk)	
	one sample	**two samples**
PG	**0.275**	0.193
WA	/	0.189
LM	0.311	0.198
PG1 (Spectra)	**0.272**	0.193
WA2 (Spectra)	/	0.182

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	RMSE Prot24h (g/100g of milk)
No correction	**0.067**
PG1 (Spectra)	**0.077**

- **Similar performances for Fat**
- **Slightly lower performances for Prot**

Take Home Message

1. **We can create a daily representative spectrum for AMS milk recording!**
2. **Results for FAT using spectrum are comparable to Peeters and Galesloot.**
3. **More results with different prediction equation are coming.**
4. **Different ways of correcting the spectra are coming.**

Thank you for attention

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Let us discuss!